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FACTORY PRODUCTION OF WOODEN BUILDINGS AND STRUCTURE

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Factory Production Of Wooden Buildings And Structures.

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1. General

(a) Advantages of prefabricated building

The housing problem is very urgent in many countries, not least in the less developed ones. Investments in building have, however, nearly always an inflatory effect, and therefore governments find it difficult to solve the problem, if they are at the same time trying to stabilize and develop their country's overall economy. Prefabrication is, in many cases, one of the ways to get a practical and feasible solution to the grave housing problem.

The prefabricated building has several advantages over the conventional:

(i) - the price of the buildings is lower. Even in countries where labour is cheap, machines still do the same work cheaper,

(ii) - the need of skilled labour is less on the building site,

(iii) - cheap and waste materials can be used to a greater extent,

(iv) - the standardization of the building components is easier,

(v) - the quality of the buildings is higher,

(vi) - the erection time is short; this is specially important in certain climatic conditions.

(b) Different forms of prefabricated buildings

There are many different degrees of prefabrication, and it depends on the local conditions which one is used.

(i) - The whole building is prefabricated

This is the most complete form of prefabrication, and also often gives the best results. The different parts of the building, that are prepared in the factory following a common plan, will surely fit together, and there is no danger of shortage of some important rawmaterial at the building site. The erection time is very short and the need of skilled labour during it is insignificant.

(ii) - Only certain parts of the building are prefabricated

Depending on local conditions (supply of raw materials, means of transportation, etc.) it may be more advantageous to prefabricate only certain parts of the building. Thus for instance only doors, windows, stairs etc. may be prefabricated in a factory and the heavier elements such as walls, beams and roofs are prepared at the building site from local raw materials.

(iii) - Technical prefabricated methods

Even if the whole building is prefabricated, two different systems can be used:

a. - The pre-cut system

In the wood-building industry, pre-cutting means that the timber components required for the construction of a building, such as joists, wall plates, studs, rafters (and, in some cases, even boards) are supplied machined and cut to length. No assembly, except that of doors and windows is done at the house factory.

In its simplest form, pre-cutting means only the cutting of timber to definite lengths. Prefabrication, however, makes use of the pre-cutting in a more developed form, which, apart from cutting to length, includes the shaping of structural components at the factory by various processes, machining, cutting, boring, pressing, gluing, and so on.

b. - The panel building system

In the panel building system, the external walls, and often partitions also, are made of panels (for instance 4'wide) the height of the wall, with windows and doors ready-fitted into the panels.

Depending on the builders' wishes and local conditions, the flooring and roofing can also be supplied in panels.
Which one of these two systems is more advantageous to use, depends on local conditions. It cannot be said that pre-cut construction is better than the panel system, or vice versa. When deciding on the type of construction to be used, it is necessary to take into account the purpose for which the building will be used, the situation of the site, transport facilities, the skill and wages of the workers and the equipment available.
The advantages of pre-cut construction are:
- small shipping space,
- easy transport, as the parcels can be made fairly small so that they are less fragile,
- the price is somewhat lower than that of a similar building in the panel construction,
- jointless walls,
- conventional appearance is easily achieved,
- conventional methods can be applied in the erection.

The components of a pre-cut building are packed in bundles or crates. In shipment they take less space than the parts of a panel house of the same size, which can be an asset where great distances and difficult transport conditions are involved.
The advantages of panel construction are:
- less work on the site, as the larger part of the work is done at the factory,
- less skilled labour is required in the erection,
- factories can exploit their abundant supplies of short timber in construction,
- fewer pieces to be handled on site.

There are many reasons why the productivity of one man-hour in a factory is greater than the same on the site. The use of permanent machinery, better working conditions etc. are all to the advantage of the factory worker. A panel building makes more use of these advantages, leaving less work to be done on the site.
The pre-cut construction is recommended when transport involves

great distances by sea, or poor communications between factory and site, and where cheap labour is available. A panel construction is recommended where labour is expensive and skilled labour difficult to obtain; and in cases where very rapid erection is required.

2. Different buildings and constructions

(a) Dwellings

This group of buildings is the most important and often forms a very serious social problem. The standard of the dwellings indicates also rather directly the standard of living of a country. Unfortunately, investments in this group have the most direct inflatory effect on the economy.

The prefabricated construction of dwellings can naturally never solve the whole problem, but experience has shown, that, in many cases, very difficult housing problems have found their solution through some kind of prefabrication. The author of this paper has gathered his experience only in the Latin-American countries, but there is reason to believe that conditions in the less developed countries in other parts of the world are similar.

The shortage of dwellings is always greatest in big cities and densely populated areas. The first step to solve the housing problem may be to build temporary dwellings. Buildings of this kind can be made either of loose timber or of prefabricated elements. Time studies have shown that in the erection of properly planned prefabricated temporary buildings so much time is saved that the elements will pay for themselves relatively quickly. In order to serve their purpose fully, these elements must be so designed that they form a complete and flexible whole.

Temporary buildings can be dismantled and re-erected several times. They can be used on one site until a permanent solution has been found to the housing problem, and after that they can be moved to some other area. Of course, there is always the danger that these temporary buildings become permanent, and the original housing problem is forgotten. Therefore, temporary buildings must be used only in most urgent cases and after careful planning.

Which material, form of building and prefabrication is used in the

construction of the permanent dwellings naturally depends greatly on the local conditions. To obtain the best results it is necessary to consider:

- modern design,
- shaping of the material by machinery,
- utilization of raw materials,
- special methods of erection.

Where timber is the traditional material for building, it still remains the basic material also in modern constructions. It can be successfully used with other materials in composite structures. Thus, in the frame of the house, timber is combined with plywood, fibre board, gypsum board, asbestos cement shingles, and so on, to form a strong and attractive structure. It can also be combibed with bricks and concrete so that the conventional local building material is dominant. When planning lowcost housing, prefabricated timber can be used successfully even in such areas, where it has to be transported considerable distances. This is especially true in those cases, where only doors and windows are prefabricated. Standardization of moulding profiles, door and window sizes, etc. becomes then much easier and falls to the benefit of the dwellers.

(b) Public and other bigger buildings

(1) Schools

In the modern world, where science and technology develop rapidly, the importance of school buildings has increased, and they have come more and more into the public eye. As the task of the school is so all-important, it is natural that serious attention should be paid to the school buildings.

In the planning of modern cities, attempts are being made to avoid barrack-like congestion and to create a community with its own public buildings, including schools, beyond the limits of an urban area and surrounded by open country. Architecture has freed itself from the traditional and grandiose styles, and today it is possible to reach a more agreeable solution by starting from the essential requirements at the centre of the problem itself. This new way of thinking is also very valuable when the shortage of schools is big, and the need for new schools has to be satisfied quickly and at low cost.

(iii) Industrial buildings, bridges etc.

In industrial buildings, bridges and similar constructions, unusually long selfsupporting spans are often required. The most usual raw materials used are steel and concrete. However, where timber is available, roof-trusses made of wood have many advantages compared with steel and concrete. They are light, easy to assemble and strong.

In many countries, the prefabrication of wooden roof-trusses and bridges has already been practised for many years and the results have been good. The biggest advantages of the prefabrication are the same as in the construction of houses.

3. Factors affecting the application of prefabricated systems

There are several local conditions affecting the feasibility of prefabrication. The most important are:

(a) Transport facilities

Transportation of prefabricated buildings and constructions generally will prove more advantageous than the transportation of raw materials because no waste material is transported. This is especially important where difficult transport conditions are involved.

(b) Availability of skilled labour

Shortage of skilled labour is a strong factor on favour of prefabrication.

(c) Local rawmaterials

Where no local rawmaterials are available, complete prefabricated buildings and constructions may be the only economical solution. Even if the heavier parts of the buildings can be constructed of local materials, a partial prefabrication often proves advantageous.

4. International cooperation in adapting prefabrication

In the above, the main aspects of prefabrication have been dealt with briefly. There is no possibility to go into great detail as the local conditions vary greatly in different areas, and the methods used have to be modified accordingly. Some questions have not been touched at all, as for instance preservation, which is of vital importance in many areas, but is in itself a separate technical matter.

In the author's opinion, prefabrication is often the right solution

The building of schools is not such an inflattory factor as the building of dwellings. It can be considered more as a profitable investment on long term basis. The communities and the government therefore do not usually hesitate to invest large sums in school buildings. In this connection, the advantages of prefabricated buildings are still more obvious than in dwellings. Especially, where a whole new school system has to be established, as is often the case in less developed areas, prefabrication can be extra ordinarily effective and economical.

In the following there will shortly be dealt with a system developed in Finland for wooden school buildings. It seems reasonable to believe that some similar system can be adapted in most areas.

Series manufacture is the basis of prefabricated house production. School buildings are based on the use of standardized building elements in which the requirements of different types of rooms have been taken into account. In this system, four ceiling heights can be flexibly used together. Wall elements, givinga ceiling height of 11'2", are suitable for classrooms. For staff rooms and other similar rooms 8' has been considered a suitable height, and in corridors 7'6". In theassembly hall and gymnasium the classroom elements can be extended by the use of the lower sections of brick, giving a total ceiling height of 16'. The use of those wallelements with four different ceiling heights is based on a 4' module, which is strictly followed.

Taking into consideration the local conditions and requirements in designing and manufacturing external walls, floors, ceilings, roofs, windows, doors and other house parts, this basic system can be modified to fit nearly everywhere.

(11) Other public buildings

In building hospitals, army barracks and canteens, and so on, the same points of view as applied to schools are important. These buildings are, like schools, usually financed by the governments and communities, which can and must direct the planning and building. It is always worth while to study the possibilities of prefabrication to reach the best economic solution in these heady investments. to the building problems. However, it must be kept in mind, that adapting prefabrication in any form is not simple, and very seldom easy.

The whole idea of prefabrication loses its value, if the work is not planned thoroughly and well. Even in the more developed countries,

much work and experience, accumulated over a long period of time, are needed when new types of prefabricated buildings and constructions are planned, and naturally this is much truer when prefabrication is being started. Haphazard efforts will certainly prove expensive and very easily get the whole method a bad name.

The easiest, quickest and safest way of adapting prefabrication is naturally the importation of prefabricated houses and constructions. Many countries have already practised prefabrication for many years and have also a long experience in exporting to and building in the less developed areas, where conditions are quite different from those in the home country.

A lack or shortage of domestic building materials makes importation the only solution in some cases. The importation of any kind of building components is however often impossible for economical reasons. Also the domestic building industry may strongly oppose the importation. Therefore the only solution is often to establish a domestic prefabricated industry. This, too, has its difficulties, where cooperation between the governments and the United Nations specialized agencies may be necessary.

The problem is naturally in the first hand economic. It may be difficult to interest private enterprises in it without some kind of guarantee. Therefore the governments may have to take the initiative.

The establishment of prefabricated factories may then be realized as follows:

(a) - Some bigger sanitation plan in or near some big city which needs immediate realization, is chosen. Quite a large number of dwellings may be involved. The government may have to finance this first project, but this is only natural, as the question usually has great social importance.

(b) - Connection is sought with some wellknown prefabricated industried abroad, which will make plans for the dwellings in cooperation with domestic technicians and architects. The form of prefabrication is chosen and the possibilities of using local rawmaterials and labour are studied. Ways of continuous cooperation are studied, keeping in mind especially the establishment of a permanent domestic prefabricated
industry.

(c) - The first dwellings are bought completely prefabricated from abroad and imported dutyfree. At the same time a company is formed with domestic and foreign capital. The foreign shareholder (a prefabricated house factory) may pay for its shares in machines,

drawings, technical help etc. This company takes care of the erection of the imported houses.

(d) - In cooperation a factory is built and a domestic staff is educated to run it independently after a couple of years.

This form of cooperation with the already existing industry of the more developed countries will surely help to avoid many mistakes and expensive experiments. The capital needed is not so important as in many other industries (e.g. pulp and paper), but it is still considerable. The industry has therefore to be established on a sound economic and technical basis.

- In Annex I and II a short calculation is given of the capital needed to establish a prefabrication factory of medium size. These figures can naturally serve only as an example of what costs have to be included in such a calculation, and gives only a general idea of the capital needed.

Other forms of cooperation are also possible (exhange of drawings and information), but in the long run a mutually established and financed industry is likely to prove most successful and guarantees a steady progress.

The establishment of a house factory — Annex I

1. - The total capital needed for setting up the factory depends to a great extent on local conditions. It is here estimated to amount to 0.6-0.8 million dollars. (Annex II)

2. - To begin with, the following machinery and equipment will be needed for the factory:

two	rip saws
one	moulder
three	cut-off saws
one	holzheer
one	tilting table circular saw
one	multiple rip saw
one	hand jointer
one	band saw
one	hollow chisel mortiser
one	air compressor
one	circular saw for cutting insulation material
	dust elevators
two	overhead cranes
	tools
	sharpening machines for moulders
	and circular saws

one lathe
one shaper
one boring machine
black-smith implements
electric welding implements

3. - The energy required by the machinery amounts to 300-500 kWh.
4. - On the above lines the factory can produce some 1000 houses of medium size annually.
5. - 70 workers, 5 foremen and 10 persons for management, sales and planning.
6. - The location of the factory depends naturally on the areas in which it is hoped to sell the houses, and how transport to those areas can be arranged at the lowest cost. It is of course advisable to have the factory near the railway and port.

Capital needed for setting up a house factory — Annex II

(Capacity about 3000 stds/year)

1. - Levelling of terrain, roadbuilding etc. (area 5 acres)	$ 25.000.oo
2. - Factory buildings	
- mill, 14.000 m^3	30.000.oo
- storage of product 35.000 m^3	100.000.oo
- shop, 375 m^3	5.000.oo
- garage, 120 m^3	3.000.oo
- office	15.000.oo
3. - Machinery	
- mill	75.000.oo
- shop	25.000.oo
- spareparts, tools etc.	10.000.oo
4. - Transport facilities	
- one forktruck	20.000.oo
- one lorry	10.000.oo
5. - Drying kiln (4-5 stds/day)	35.000.oo
6. - Power station (steam 5-6 ato)	40.000.oo
7. - Transformer	5.000.oo
8. - Preservation plant	20.000.oo
9. - Office furniture and machines, etc.	15.000.oo
10. - Rawmaterial	
- sawn timber, boards, nails etc.	100.000.oo
	523.000.oo
+ about 15%	77.000.oo
Total	$ 600.000.oo

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